

## Discussion on "Tuner Design for RIA" by Brian Rusnak

The question was asked, how the VCX compares to a PZT fast tuner. Shepard answered that so far PZT is only proposed for feed forward compensation of pulsed operation, while VCX is proposed to control microphonics. Pagani added that there are investigations for TESLA to extend the use of PZTs to microphonics compensation too.

The experience base of PZTs was discussed next. There was preliminary work at LANL on the Scruncher cavity, which was a single cell with a small mode spectrum. There was general agreement that PZT needs some long term demonstration.

Shepard next pointed out that the availability requirements for RIA require a good understanding of the microphonics issue (e.g. due to coupling of the resonator mechanical resonances to the excitations from the cryo system). The resonances are in part due to a complex 2-phase flow in the cryogenic system, this effect is already seen in the ATLAS accelerator. Mike Kelly added that pressure changes as small as 1-2 Torr can be seen in the system. Solutions to mitigate microphonics issues are either overcoupling at the price of a huge increase in the power needed (requires 10 and 50 kW couplers), or a very good and fast RF control (requires only 1 and 5 kW couplers). He and Rusnak believe that the VCX could be a good engineering solution for stable operation at reasonable cost, whose feasibility has to be demonstrated however.

To further emphasize the importance of microphonics he commented that thin solid niobium resonators as proposed for RIA are much more sensitive to microphonics than niobium sputtered on copper cavities as used by Legnaro and CERN.

Kelley proposed to attach the origin of the problem in the cryosystem, instead of putting the burden onto a complicated RF-control in the resonators. Shepard agreed that it is desirable to study this option.

The cost advantages shown for the VCX include all secondary components required for their operation. Facco pointed out that VCX tuners add complexity to the system due to operating "multiple--component" devices in a cryogenic environment. Rusnak agreed that an overall system study needs to be done to assess the added risk vs. the cost reduction.

The final remark of the discussion pointed out that this is probably a 4K operation problem, as TESLA in its 2K system does not see large microphonics effects.